COOPERATIVE NATIONAL PARK RESOURCES STUDIES UNIT

UNIVERSITY OF HAWAII AT MANOA

Department of Botany
3190 Maile Way
Honolulu, Hawaii 96822

(808) 948-8218

Technical Report 56
VASCULAR PLANTS OF PU'UHONUA O HŌNAUNAU NATIONAL HISTORICAL PARK, HAWAI'I

Technical Report 57
VEGETATION MAP OF PU'UHONUA O HŌNAUNAU NATIONAL HISTORICAL PARK, HAWAI'I

Technical Report 56
by
Clifford W. Smith, Lani Stemmermann,
Paul K. Higashino, and Evangeline Funk

Technical Report 57
by
Jack Leishmann

February 1986

UNIVERSITY OF HAWAII AT MANOA

NATIONAL PARK SERVICE
Cooperative Agreement No. CA8008 2 0001

VEGETATION MAP of PU'UHONUA O HŌNAUNAU NATIONAL HISTORICAL PARK, HAWAI'I

Jack Leishmann
Department of Geography
University of Hawaii at Manoa
Honolulu HI 96822

ABSTRACT

This report presents a map of the vegetation of Pu'uhonua o Hōnaunau National Historical Park. With the exception of the managed areas in and around the primary cultural features, and a very narrow beach-strand and spray zone area, the majority of the vegetation in the park is alien, a large proportion in woody leguminous shrubs with sizeable areas of introduced grasslands. A few native species, and widespread Polynesian introductions, are scattered throughout the communities. The vegetation can be grouped into four components based on the structure and species composition: 1) a narrow salt-spray and beach-strand zone nearest the ocean; 2) a managed woodland composed mostly of Polynesian introduced coconut; 3) grasslands dominated by introduced species; and 4) a mixed shrubland also dominated by alien species. A total of 26 symbols were used to construct the map units for the 182-acres of vegetation. It is uncertain which plant species were found in the refuge area at the time of European contact. Most of the surrounding area was probably barren lava with patches of pili grass (Heteropogon contortus).

INTRODUCTION

Resource management in the National Parks is becoming more sophisticated. At the same time, the scope of management activities is expanding so that all resources are subject to preservation. However, in order to manage the resources, one needs to know what is present and where it is located. To this end, a checklist of plants at Pu'uhonua o Hōnaunau National Historical Park (Smith, Stemmermann, Higashino and Funk 1986) was recently completed.

The present study was designed to map the principal plant communities and measure their areal extent.

STUDY AREA

Location and General Description

Pu'uhonua o Hōnaunau National Historical Park (PUHO) is located on the western, or Kona, coast of the Island of Hawai'i, approximately 2.5 miles south of Kealakekua Bay. The Park currently encompasses about 182 acres "...set apart by act of Congress for the benefit and inspiration of the people." (National Park Service 1975). The current western boundary is along the mean high tide line of the indented bare lava coastline; the north-south extent of the Park is about 1600 m, varying in width from about 250 to 750 m to the eastern or mauka boundary.

The Park is located on the lower, leeward slopes of the currently active volcano, Mauna Loa. Lava flows from the 1951 Mauna Loa eruptions reached the sea a few miles south of the Park boundary. Recent 1975 and 1983 Mauna Loa eruptions did not flow toward the Kona coast.

The major physical features are the gently sloping, smooth pāhoehoe lava substrate that cover most of the Park area, and the steep, crescent-shaped fault scarp (Keanae'e Pali), located near the southern boundary. Recent localized earthquake activity has been historically associated with this fault scarp; a severe earthquake in 1951 toppled buildings in the area (National Park Service 1975). Most of the Park is below 10 m elevation, with the highest elevation in the Park at about 40 m, just mauka of Keanae'e Pali

The primary purpose of the Park is the preservation and interpretation of major Hawaiian cultural features including the Great Wall (Pā pu'uhonua) which encloses the place of refuge; the partially reconstructed Hale o Keawe; the historically occupied Ki'ilae village site, three Hawaiian slides or Hōlua; and assorted archaeological ruins.

The current master plan for the Park calls for the addition of 204 acres of land and 112 acres of intertidal and

inshore areas to incorporate management and protection of other cultural and natural features associated with PUHO (National Park Service 1977).

Climate

The Kona coast is noted, within the Hawaiian chain, for its atypical weather patterns, particularly in regards to rainfall and wind. The mornings are usually clear, and as the land heats up, cool landward breezes begin to blow. By early afternoon, cloudiness increases and rain falls at higher elevations. In the evenings, as the land cools, light offshore winds flow off the mountain slopes and the cloudy conditions cease. Nights are ususally cool and cloudless (Blumenstock and Price 1967).

Trade wind showers are uncommon because they are blocked by the large mountain masses of Mauna Loa, Mauna Kea, and Hualälai. In the central and southern Kona coastal area, average rainfall is greater from May through September than during the rest of the year, a condition unique with the Hawaiian archipelago.

Temperature is strikingly constant from month to month. Annual average maximum temperature is 88°F (31°C) and the average minimum is 65°F (18°C). Diurnal temperature variation averages about 20°F (11°C). Coastal rainfall is low and relatively constant throughout the year, averaging a little over two inches (50 mm) per month. Average annual rainfall is about 35 inches (875 mm). (Median anuual rainfall at Näpõ'opo'o, about eight miles north of Pu'u o Hönaunau, at 480 ft. (160 m) elevation, is about 40 in. (1000 mm) per year.

Relative humidity is essentially constant throughout the year. The average daily maximum ranges between about 85 and 90 percent during any month, while the minimum average varies between about 55 and 65 percent.

Soils and Substrate

True soils are not well developed in the study area. Most of the Park has been surveyed as having a pähoehoe lava substrate with no soil profile (U.S.D.A. Soil Conservation Service 1973). Most of the vegetation is rooted in cracks in the lava flows or between rocks; drainage in the area is considered excessive. The very southern end of the Park, adjacent to Ki'ilae Bay, has been mapped as Rough Broken Land, also with little to no profile development. This area is also excessively drained (U.S.D.A. Soil Conservation Service 1973).

Small areas with thin soil development exist just south of the Park administrative buildings, between the coastal strand and the 1871 horse trail. These areas are slight topographic depressions and appear more mesic than surrounding areas.

Calcareous beach sand deposits occur paralleling the shoreline along most of the Park's length. The sand forms a narrow strand and berm complex just inland of the barren lava spray/splash zone. The beach soils are also poorly developed with no profile differentiation.

METHODS AND MATERIALS

Reconnaisance and Mapping Unit Selection

A NASA 1976 false infra-red aerial photograph at a scale of about 1:7800 was used to locate provisional community boundaries. A preliminary field map was constructed based on color, brightness and texture of signatures. This map was then field-checked by comparing it with the actual vegetation, and boundaries were assigned as accurately as possible. All map units were checked for accuracy in the field.

Mapping

The vegetation map was drawn using the 10 November, 1976 false color infra-red photograph enlarged to a scale of 1:7800. A final draft map was traced onto a mylar sheet and photographically enlarged. Labels were then imprinted and the map was reduced to the final working size.

RESULTS AND DISCUSSION

General Observations

The majority of the vegetation in the Park is composed of weedy, exotic species, primarily grasses, sedges, and low statured shrubs (nano-phanaerophytes), forbs (chamaephytes), and trailing vines. Exotic trees, such as opiuma (Pithecelobium dulce), kiawe (Prosopis pallida) and rain-tree (Samanea saman) are scattered, usually as individuals, throughout the Park. Groves of coconut (Cocos nucifera), many of them planted, are found on the makai or shore side of the Park, particularly in association with the Hale-o-Keawe, Great Stone Wall, and related ancient cultural features.

The vegetation of the Park can be grouped into four components based on the structure and species composition: 1) a narrow salt-spray and beach-strand zone nearest the ocean; 2) a managed woodland composed mostly of Polynesian introduced coconut; 3) grasslands dominated by introduced species; and 4) a mixed shrubland also dominated by alien species.

The salt-spray and beach-strand vegetation forms a narrow belt along the makai (seaward) edge of the Park (see map at end of report). Growing in otherwise barren pāhoehoe lava, the Polynesian introduced sedge (Fimbristylis cymosa) is found growing in pure stands of scattered clumps in cracks and sediment-filled depressions. Along a narrow berm of

calcareous sand, just inland of the rocky coastal flats there is a strand community with an overstory of coconut, and a sparse understory of indigenous circumtropical coastal species.

Inland from the strand-zone to the 1871 trail (which bisects the Park in a north-south direction paralleling the coast) several different plant communities are found. In the northern section, particularly in association with the ancient cultural features, groves of coconut predominate. Small stands of other tree species, including Polynesian and later European introductions also occur in this area. South of the coconut groves the vegetation is composed mostly of introduced grasses such as Natal red-top, bermuda grass and Guinea grass, with a mixture of low-growing exotic shrub and forb species. Climbing over the stone structures, such as house platforms and stone walls is the passion flower vine, Passiflora foetida.

The area east, or inland from the 1871 trail is dominated by exotic shrubs varying from low statured in the northern part to moderately tall koa haole in the southern part. Opiuma becomes an important member of the community in the area both just above and just below Keanae'e Pali.

Vegetation Map

The communities are labelled on the map using a combination of symbols derived from generic names, plant cover designation, vegetation structure, or other predominate surface features (Table 1). A total of 26 symbols were used to construct the map units. Symbol combinations begin with a letter indicating the structure of the community (e.g. open or closed; grassland; tall statured or short statured) and are followed by the dominant plant species in order of cover. Less common, though important species follow in parentheses. In some cases individual species are not listed when several constitute a typical group for an area (e.g. exotic grasses, sedges) and are in their order of cover in the community.

Closed canopy was defined as 60% or more cover (as estimated by the vertical projection of the average crown or shoot area to the ground). Open canopy was defined as 30-60% cover. To distinguish community types that were similar in species composition but differed in statured, the symbols for short-statured and tall-statured were used. Short-statured refers to communities dominated by plants less than 2 m tall while tall-statured communities average two or more meters in height.

Past Hawaiian Activity

Continuous occupation of the Pu'uhonua-o-Hōnaunau area by ancient Hawaiians and their descendants has occurred from prehistoric times (at least as early as 1125 A.D.) until the

present (National Park Service 1977). The Ki'ilae Village site, at the southern portion of the Park was occupied until the 1920s.

This pu'uhonua, translated as "Place of Refuge", was one of six such areas of asylum located on the island of Hawai'i, one for each of the chiefdoms originating after the death of High Chief Liloa in about 1475 A.D. (National Park Service 1977). Each was a place of safety for those individuals who had committed serious crimes or who were fleeing battle. Once within the confines of the pu'uhonua, they were safe from retribution and punishment.

Several structures are associated with pu'uhonua, including the reconstructed Hale-o-Keawe, the massive stone enclosure or Pā pu'uhonua, several heiau platforms or temple sites, house sites, and Hawaiian sledding ramps or holua. The major archaeological remnants are stone structures, elevated from the natural landscape.

It is uncertain exactly what plant species were found in the refuge area at the time of European contact. It appears that most of the surrounding area was barren lava with patches of pili grass (Heteropogon contortus). Niu (Cocos nucifera), noni (Morinda citrifolia), kou (Cordia subcordata) and other useful Polynesian introductions were undoubtedly cultivated in the area.

Following the breaking of the kapu system in 1819 and rapid decline of Hawaiian religion and culture, the signficance of the pu'uhonua was greatly diminished. Exotic plant and animal species were introduced to the area very early in the 19th century. Cattle, pigs, and horses proliferated. Highly nutritious browse species, particularly legumes like opiuma, koa haole, and kiawe, were all well-adapted to and spread quickly over the barren lava slopes.

After accession of the area into the National Park System in 1961, the Park management undertook to remove exotic vegetation in the mauka section. However, the extent and persistence of exotic shrubs and grasses has limited management to periodic clearing of the cultural features and the replanting of coconut trees. Attempts have been made to reintroduce native pili grass, but exotic plants, particularly Natal red-top, outcompete the native species. In 1978 a fence was constructed along the mauka boundary of the Park to keep cattle from grazing the Park area. While this has reduced damage to archaeological features, shrub species have increased in cover since fencing (Jerry Shimoda, pers. comm.), and large areas of the Park are more vegetated than at any time in the past.

Present Plant Communities

With the exception of the managed areas in and around the primary cultural features, and a very narrow beach-strand and spray zone area, the majority of the vegetation in the Park is alien, a large proportion in woody leguminous shrubs with sizeable areas of introduced grasslands. A few native species, and widespread Polynesian introductions, are scattered throughout the communities.

Most of the area in the northwest portion of the Park encompassing the primary cultural features is dominated by coconut and other Polynesian introductions such as kukui, noni, and hala, as well as exotic ornamentals such as raintree, African tulip tree and ?golden shower tree. While coconut is the dominant overstory tree in this area, the understory communities vary significantly depending on substrate, management practices, and the openness of the overstory.

The narrow coastal strand and spray-zone is dominated by two community types. Single-species stands of the indigenous sedge, Fimbristylis cymosa, occur as clumps rooted in cracks in the otherwise barren-strand community, with a partial overstory of coconut and a very sparse understory of widespread indigenous coastal species such as pohuehue, 'ilima, and naupaka kahakai and the endemic sedge Cyperus hypochloris. A few scattered individuals of kiawe also compose the beach-strand overstory.

The majority of the grasslands occur on the seaward side of the 1871 horse trail. Large expanses of Rhynchelytrum repens (Natal red-top) dominated grassland occur on the pāhoehoe flows east of the administration buildings and in scattered stands throughout well-drained substrates of the Park. Just inland from the beach-strand and south of the administration buildings are found mesic grasslands of nearly pure Cynodon dactylon. These occur in very flat areas that are slight topographical depressions relative to their surroundings. Cynodon grassland also occurs on the landward side of the beach berm south of the coastal trail.

The shrub communities, which occupy most of the Park's area vary more in stature and relative abundance of species than in differences in species composition. Two or three recognizable community groups can be observed within the general type. These include a tall statured, koa haole dominated shrubland, with mixed exotic trees such as opiuma and kiawe and an understory primarily of Guinea grass; a short statured koa haole dominated shrubland with a varying mixture of xerophytic exotic and Polynesian intrduced shrub, forbs, and herbs, such as Waltheria americana, Rhynchelytrum repens, and Passiflora foetida; and a mixed shrub and grassland community, made up of similar species but with a reduction of koa haole.

LITERATURE CITED

Blumenstock, D.I., and S. Price. 1967. Climates of the States: Hawaii. U.S. Environmental Data Service, Climatography of the United States, No. 60-51.

Smith, C.W., L. Stemmermann, P.K. Higashino, and E. Funk. 1986. Vascular Plants of Pu'uhonua o Hōnaunau National Historical Park, Hawai'i. CPSU/UH Tech. Rep. #56. (Botany Dept., Univ. of Hawaii at Manoa, Honolulu).

National Park Service. 1976. Final Environmental Statement. Proposed Master Plan for City of Refuge National Historical Park, Hawaii. 56 pp. + attachs.

National Park Service. 1977. Master Plan. City of Refuge National Historical Park. 33 pp

U.S.D.A. Soil Conservation Service. 1973. Soil Survey of Island of Hawaii, State of Hawaii. 115 pp. + 195 maps.

Table 1. Map symbols used for vegetation unit descriptions: Pu'uhonua o Hōnaunau National Historical Park, Hawai'i

B....Barren areas (Lava rock, cultural features, barren sand, roads)
C....Closed (>60% cover), used only in combination
Cd...*Cynodon dactylon* dominated
Cn...*Cocos nucifera* dominated
Co...*Cassia occidentalis* dominated
Fc...*Fimbristylis cymosa* dominated
G....Grassland dominated cover type
e....Exotic species
f....Forbs
Ll...*Leucaena leucocephala*
m....Mixed shrub and grassland/forbs
MO...Mixed ornamental trees
Mc...*Morinda citrifolia* co-dominated
n....Native species
O....Open (30 - 60% cover), used only in combination
p....Polynesian introduced species
Pm...*Panicum maximum*
Pf...*Passiflora foetida* dominated or co-dominated
Pc...*Pithecellobium dulce* dominated or co-dominated
Pp...*Prosopis pallida* dominated or co-dominated
Rr...*Rhynchelytrum repens* dominated or co-dominated
s....Sedges (*Fimbristylis* and *Cyperus*)
sh...shrubs less than 2 m tall
Ss...*Samanea saman* dominated
t....shrubs more than 2m tall

VEGETATION MAP: PU'UHONUA O HŌNAUNAU (CITY OF REFUGE) NATIONAL HISTORIC PARK, HAWAI'I